
Space Weather Technical Forecast

Issued on Sunday, 24 July 2022 at 13:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Risk of G1 abating, replaced by rising Chance of Active electron fluence. Slight Chance of R1/R2 throughout. Large far-sided CME observed.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has remained Low through the last 24 hours, with activity at GOES16 confined to peaks of mid C-class. These flares included a C3.6 at 23/2241UTC and a C2.6 24/0724UTC, with both of these appearing to emanate from the vicinity of Ex-3057 on the northwestern solar horizon, with the latter perhaps also bolstered by a concurrent southwest limb prominence eruption Coronal Mass Ejection (CME). This prominence eruption has yet to be modelled, pending further imagery.

Coronagraph imagery was otherwise dominated in the 24 hours by a large full-halo signature on Lasco C2 and C3. This has been submitted for Enlil modelling but appears linked to the far side. The bulk of ejecta from this event was visible heading southwest in the plane of the sky, with a more subtle portion also heading northeast. To complicate matters, there was a possible candidate for a filament eruption that immediately preceded this far-sided event on the southwest of the Earth-facing disc. The pattern of ejecta has been analysed extensively, and so far there is no conclusive tie to any front-sided CME, however this is actively being confirmed.

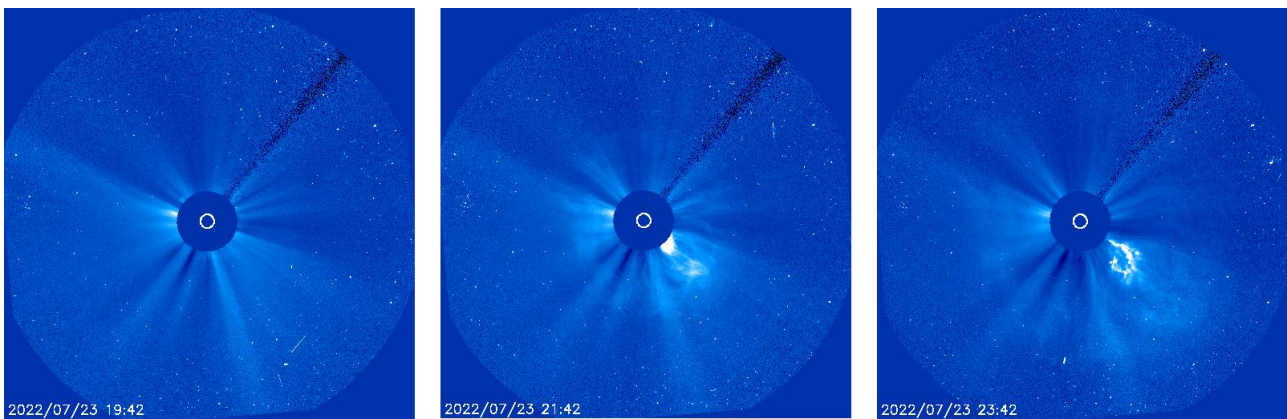


Figure 0: Lasco C3 imagery sequence of the aftermath of a far-sided CME. A full-halo shock is visible as well as the main core of the CME heading southwest. Ejecta tied to this event is dominating the current field of view and complicating identifying any minor front-sided CMEs in the period.

As a further subtlety, there was another faint emission seen in Lasco C3 heading along the earlier track of the main southwestern portion of the far-sided CME. This could not be conclusively tied to anything in COR2, and as such is considered a low confidence emission from a similar location to the earlier far-sided halo.

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At present then, no Earth-bound CMEs are envisaged, however this statement carries lower-than-average confidence.

The solar disc was populated by six sunspot regions, with AR3063 re-emerging from an earlier plage remnant - the main dynamic feature on the disc now Ex-3057 has rotated off. The remainder of the sunspot regions were all relatively uncomplicated dipoles, with the exceptions of a pair of Zurich Hsx groups, which were unchanged.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by DSCOVR at L1, was characteristic of the tail end of influence of the 21 July CME, possibly segueing into the earlier incumbent high speed stream from coronal holes 01 and/or 02. The CME itself arrived at Earth prior to this 24-hour period, at 23/0258UTC.

The solar wind speed showed an erratic tendency mostly within the 500-550km/s range in the period. The solar wind density fell slightly over the same interval from around 10ppcc to more typical single-figures ppcc. The IMF showed a relatively stable magnitude around 6nT, with the north-south component possibly completing a damped sweep through aligned to mainly anti-aligned (with Earth's field) in a possible weak magnetic cloud signature, from +5 to -4nT before a smaller scale and more erratic variation took hold later in the period.

There was a discontinuity seen in DSCOVR data around 24/2100UTC, however this does not clearly manifest at ACE, and may therefore not be linked to any definite passing feature. Finally, the phi angle was mainly negative (towards the Sun), but with a more variable character developing with time, especially during the early hours UTC.

The net result of the above solar wind measures was for mostly Unsettled Kp, with a provisional peak Kp of '3o' observed in the 00-03UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV), as measured by GOES16 was at Background levels.

High energy electron flux (greater than 2MeV) varied between Moderate and Normal Background levels, with a peak of around 700pfu observed around 23/1600UTC. Electron fluence has followed a declining trend, and has remained well below the Active threshold, falling to 1.61e7 integrated pfu by 24/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Activity is Likely to remain Low, with a daily Slight Chance of M-class flares.

Solar Wind / Geomagnetic Activity: The 21 July CME is now largely thought to have passed. At present, no further Earth-bound CMEs feature in the forecast, however this carries lower confidence than is typical, and further analyses are being conducted.

The current high speed stream from CH01/02 is the only one to feature in the forecast, and should wane in earnest to start the coming UTC working week. Quiet conditions should predominate from day three, Tuesday 26 July.

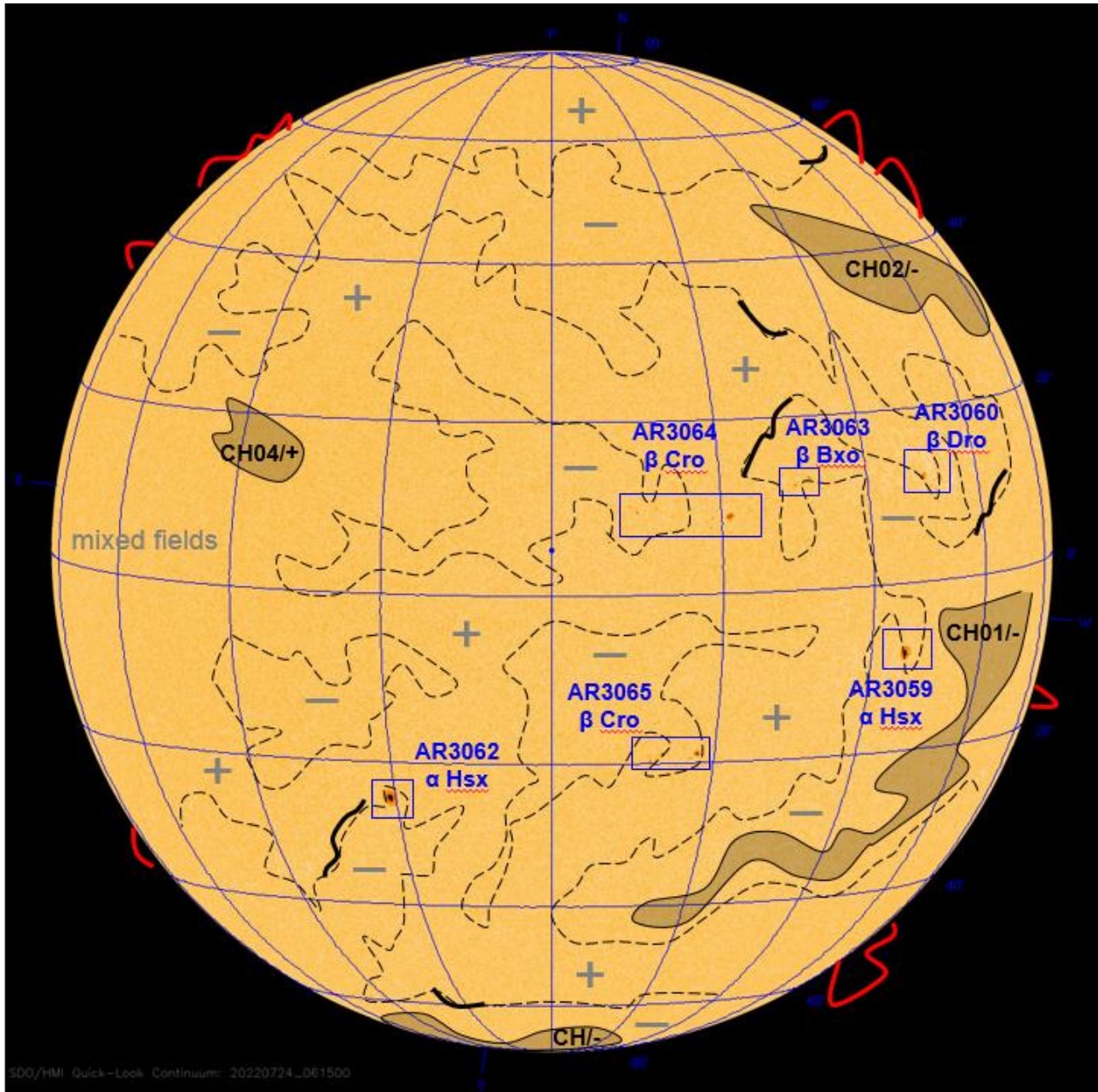
Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels.

The high energy electron flux (greater than 2 MeV) is expected to vary between Background and Moderate levels initially, with an increasing risk of exceeding the high (1e3 pfu) threshold into the new UTC working week. The rationale for this is waning geomagnetic activity and the realisation of the current high speed stream's effects.

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Electron fluence is forecast to follow a generally increasing trend through the period, with a Chance of exceeding the Active ($1e8$ integrated pfu) level, plateauing from Tuesday 26 July.

Figure 1. Solar Analysis Valid 24/0615UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

The 21 July CME's effects are now considered to have passed, with a resumption of the earlier fast wind from one or both of a pair of negative polarity high speed streams now in course. STEREO A MAG and PLASTIC data suggests that this fast wind ought to be in decline into the new working week UTC, such that by Tuesday 26 July Quiet conditions ought to be predominant.

No further persistent features are in the current forecast, nor any transients, however confidence in the latter is lower than usual for a number of events observed in the past 24 hours.

By far the most notable event in the past 24 hours in coronagraphs was a large far-sided CME, visible as a full halo on Lasco, but with the bulk of material appearing to leave the disc to the rear-facing southwest. Accompanying this was a halo shock and perhaps also a tied portion of ejecta heading northeast on the far side. Just prior to this event there was some movement visible in a filament on the Earth-facing southwest disc, as well as a few minor dimmings in AIA211 through the course of the UTC afternoon, mostly in the western solar hemisphere. At the time of writing, there is no confirmed CME with any Earth-bound component, but this remains an active field of analysis, and should thoughts change the forecast will be suitably updated.

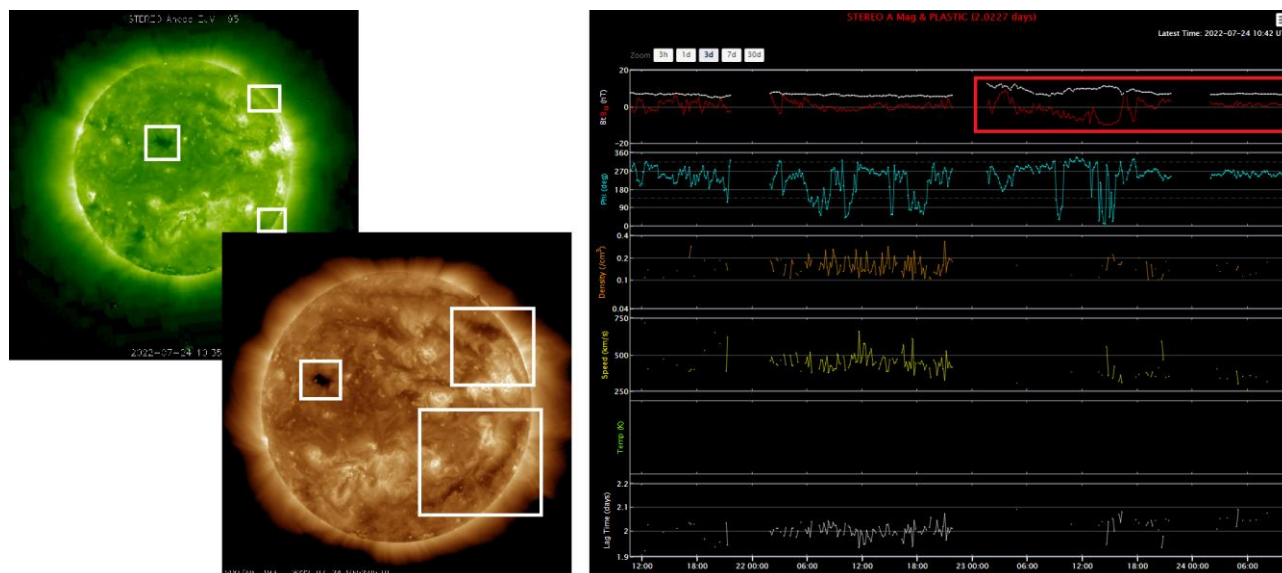
There was a later, more distinct prominence eruption also observed in the period from the southwest limb around 24/0730UTC. At the time of writing there is insufficient imagery for an analysis, however any Earth effect is considered relatively unlikely from such a westward location.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: STEREO A EUVI 195 imagery and SDO AIA 193, showing boxed analgous coronal holes in white (clockwise from left: CH04; CH02; CH01). Also shown is the solar wind for the past three days at STEREO A, showing an expected upcoming decline at Earth from current values near 500km/s from either CH01 or CH02. The influence of the 21 July CME at STEREO can be seen boxed red, perhaps also the cause of the concurrent data drop-out for the PLASTIC instrument.



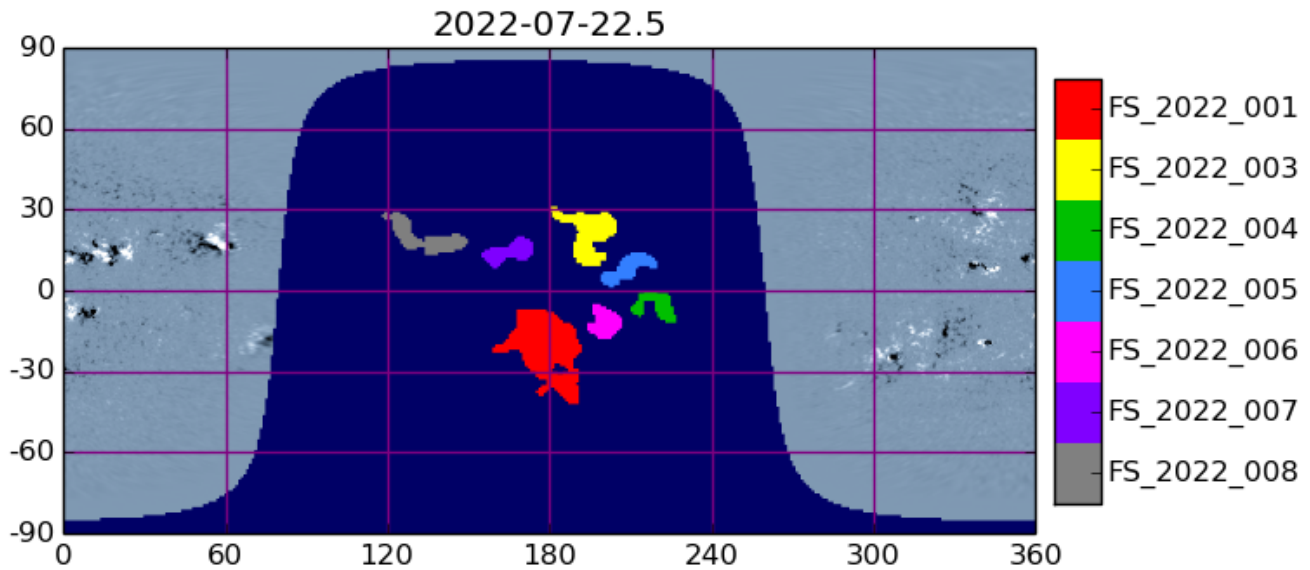
Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the last 24 hours, with modest C-class flare observed. Although so far relatively small in stature, the cadence and size of these C-class flares did represent something of an increase in activity compared to the preceding 24 hours, although the sunspot that has mostly accounted for this increase is now on the far side of the disc (Ex-3057).

Barring development, two further regions should leave the Earth-facing disc in the period, however the eastern hemisphere far side is congested with the expected returning Carrington locations of numerous regions in the four days, such that activity ought to be maintained, pending proper analysis of any arrivals.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Far side sounding of possible active regions. Whilst from two days ago, the more direct 'line of sight' through the Sun perhaps offers a better glimpse as to the possible size and scale of upcoming eastern solar horizon arrivals in the period.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels. As most regions are small and relatively magnetically simple, the risk of a proton enhancement is very low.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}^*$	No	1	1	1	1
* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)						

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2MeV) is expected to respond with an increasing amplitude oscillation in the coming 24 hours, probably in a manner roughly akin to the past rotation. The rationale for this is that the fast wind from the current persistent coronal hole(s) CH01/02 appears to have out-lasting the 21 July CME's effects to continue to charge the Van Allen belts to some degree.

The risk of 24-hour integrated fluence breaching Active is therefore upwards, probably finding its level at the very start of the coming working week UTC before stabilising.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	1	30	40	40
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 4: Past three days in high energy electron flux at GOES16 (top), with driving L1 solar wind speed (middle, with 21 July CME's influence boxed in red). Shown at the bottom is REFM, which has adapted its most recent forecast downwards, however given the easing of the CME effects and the resumption of the preceding fast wind regime, there is still considered a Chance of an upward reaction in fluence that may breach Active, probably complete by Tuesday 26 July.

